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NEW ENGLAND NOTE

AEGAGROPILOUS *DESMARESTIA ACULEATA* FROM NEW HAMPSHIRE

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Although most seaweeds are anchored solidly by their holdfasts, unattached populations are common in calm bays, fjords, salt marshes, and estuaries throughout the world (Benz et al. 1979; Dawes et al. 1985; Josselyn 1977; Orth et al. 1991; Phillips 1961; Zobell 1971). Five somewhat arbitrary and overlapping categories of unattached seaweeds can be recognized (Norton and Mathieson 1983): (1) entangled: highly branched and intertwined plants [e.g., *Bonnemaisonia hamifera* Har., *Gracilaria tikvahiae* McLachlan, and *Hypnea musciformis* (Wulfen in Jacq.) J. V. Lamour.] that occur among other drifting seaweeds and may include multiple plants or taxa; (2) loose-lying: completely unattached plants such as the saltmarsh fucoids *Ascophyllum nodosum* (L.) Le Jol. ecad *scorpioides* (Hornemann) Reinke and *Fucus vesiculosus* L. ecad *volubilis* (Hudson) Turner; (3) embedded: plants that lack a holdfast and are partially buried in sand or mud (e.g., *Fucus cottonii* Wynne et Magne); (4) free-floating: entangled and drift plants like *Sargassum natans* (L.) Gaillon; and (5) aegagropilous: spherical masses of radially arranged branches that are composed of either single or multiple plants held together by interlocking branches [e.g., *Pilayella littoralis* (L.) Kjellm. and *Spermothamnion repens* (Dillwyn) Rosenv.].

Of the 328 species of unattached seaweeds recorded by Norton and Mathieson (1983), 146 were loose-lying, 62 free-floating, 58 entangled, 53 aegagropilous, and 9 embedded. The aegagropilous taxa included 25 red, 18 green, and 10 brown algae. Some of the best known ball-forming algae are produced by freshwater and marine species of *Cladophora* (Hoek 1963; Newton 1950; Sakai

Figure 1. Two aegagropilous specimens of *Desmarestia aculeata,* with the sample on the left being more compacted and spherical than the one on the right; scalar = 5 cm.

1964), with the famous Japanese "lake-balls" designated as natural monuments (Kurogi 1980). According to Newton (1950), *Cladophora* balls occur sporadically, sometimes cast up in enormous numbers and at other times totally absent. Aegagropilous species, like most other unattached seaweeds, originate from attached plants, and they usually become infertile and reproduce entirely by vegetative means (Fritsch 1935, 1945).

The present paper reports the occurrence of two aegagropilous specimens of *Desmarestia aculeata* (L.) J. V. Lamour. (Desmarestiales, Phaeophyceae; Figure 1) that were collected at Concord Point (43°01′00″N, 70°43′55″W), Rye, New Hampshire on February 6, 1998. It is a common perennial (cf. Mathieson and Hehre 1982; Taylor 1957) that grows attached to solid substrata within subtidal environments throughout the eastern (Portugal to Iceland and Greenland) and western North Atlantic (New Jersey to the Canadian Maritimes), the North Pacific from Oregon to the Aleutian Islands of Alaska, the Bering Sea, Kurile Islands, and Russia (Mathieson 1979; Scagel et al. 1986; South and Tittley 1986). We believe this represents the first record of *D. aculeata* growing in an aegagropilous habit, as only free-floating or entangled masses have been previously reported (Norton and Mathieson 1983). Drift material of *D. aculeata* is common in the Gulf of Maine, where biomass values in excess of 11 kg wet wt. m^2 may occur after major winter storms (Mathieson, unpubl. data).

One of the two *Desmarestia* balls was found within a deep tidal pool, while the other occurred within a tidal channel that was closed at one end and open to strong wave action at the other. The specimens (Figure 1) were approximately the size of a tennis ball (7.5 × 7.5 cm and 7.5 × 8.5 cm). They were composed primarily of entangled, "wiry", and very spiny *Desmarestia* fronds, which were flatter than most terete, attached specimens. A diverse assemblage of plants, animals, and shell fragments was associated with the *Desmarestia* balls: the cord grass *Spartina alterniflora* Lois.; the seaweeds *Chaetomorpha linum* (O. F. Müll.) Kütz., *Rhizoclonium tortuosum* (Dillwyn) Kütz., *Chondrus crispus* Stackh., *Polysiphonia fucoides* (Huds.) Grev., and *Ptilota serrata* Kütz.; plus the invertebrates *Dynamena pumila* (L.), *Membranipora membranacea* (L.), *Tubularia* sp., and *Mytilus edulis* L.

As noted by several investigators (cf. Fritsch 1935, 1945; Gibb 1957; Nakazawa and Abe 1973; Sakai 1964; Yoshida 1963), the aegagropilous morphology results from a variety of factors, including detachment/breakage, oscillating movement of fragmented materials, meristematic injury, scar tissue development, and extensive regeneration and/or proliferation of new growth. Subsequent rolling and further injury causes pruning, proliferation, and compaction, resulting in a dense, spherical structure.

In the case of *Cladophora,* aegagropilous specimens are composed of entangled masses of filaments bound by rhizoids. In old *Cladophora* balls the center often decays, leaving a cavity; younger balls may form several concentric layers. The "beach form" of the temperate North Atlantic *Ascophyllum nodosum* [i.e., either *A. mackaii* (Turner) Holmes et Batters or *A. nodosum* ecad *mackaii* (Turner) Cotton of different investigators] is one of the most highly modified spherical forms (Gibb 1957; South and Hill 1970). Two temperate aegagropilous seaweeds form extensive blooms, including the persistent nuisance brown alga *Pilayella littoralis* in Massachusetts and the ceramialean "red tide" alga *Spermothamnion repens* in southern New England (Wilce et al. 1982). Tropical and subtropical seaweeds form similar structures; detached *Caulerpa racemosa* (Forsskål) J. Agardh and *Bryotham-*

nion seaforthii (Turner) Kütz. form ball-shaped masses after exposure to gentle water motion near coral reefs and within mangrove canals (Almodovar and Rehm 1971). Nuisance populations of lagunal ball-forming *Cladophora prolifera* (Roth) Kütz. occur in Bermuda (Bach and Josselyn 1978).

The crustose coralline red alga *Lithothamnion glaciale* Kjellm. may form free-living balls or rhodoliths on sandy or gravelly substrata in quiet bays in Newfoundland (Hooper 1981). Ice is instrumental in these habitats as it breaks off the calcareous crusts, allowing small fragments to roll around and acquire a distinctive ball-shaped configuration. Extensive populations of rhodoliths (*Lithophyllum* and *Lithothamnion* spp.) also occur in the Gulf of California (cf. Bosence 1983; Foster and Riosmena-Rodriguez 1999; Steller and Foster 1995) where they constitute major sources of carbonate sediment and habitats of high diversity (Foster et al. 1997). In contrast to the production of ball-shaped structures from living, photosynthetic seaweeds, balls are also produced from dead leaf and rhizome materials of the Mediterranean seagrass *Posidonia oceanica* (L.) Delile. In a series of experimental evaluations, Cannon (1979) demonstrated the importance of oscillating water motion, clumping, compaction, and disintegration of detrital materials in the formation of *Posidonia* balls.

Apparently, frond detachment in *Desmarestia* is followed by injury to its intercalary meristem, resulting in the loss of trichothallic hairs and a lack of proliferations. Its ball-shaped morphology probably develops because of rolling and compaction of residual branches, plus the incorporation of "foreign" materials. The retention of detached *Desmarestia* fragments within deep tide pools or semi-enclosed tidal channels may provide a vehicle for consistent movement (rolling) and compaction.

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